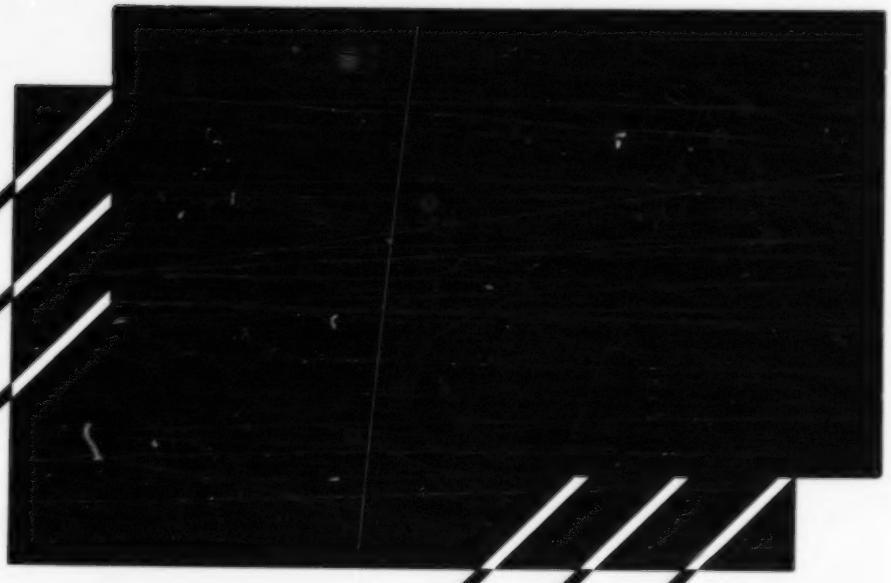
Gouvernement du Canada
Ministère des Communications

Government of Canada
Department of Communications

Le Centre canadien de recherche sur l'informatisation du travail
Canadian Workplace Automation Research Centre



Canada

Communications Canada
Canadian Workplace Automation Research Center
Organizational Research Directorate

WORK, WORK, WORK : IMPACTS OF OFFICE AUTOMATION ON WORK, WORKERS, AND WORKPLACES

Executive Summary

Susan Clark
Mount Saint Vincent University

Margaret Dechman
Mount Saint Vincent University

Pleasantine Drake
Architectural Diagnostics

Laureen Snider
Queen's University

April, 1987

CC-CWARC-DLR-85/6-001

WORK, WORK, WORK : IMPACTS OF OFFICE AUTOMATION ON WORK, WORKERS, AND WORKPLACES

Executive Summary

This report investigates the consequences of introducing an integrated computer system into an ongoing office environment. The research was conducted under the Office Communications Systems (OCS) program that was established by the Canadian federal governmemt in 1980. This $ 12 millions project was a joint initiative of the Minister of Communications, the President of the Treasury Board, and the Minister of Regional and Industrial Expansion. The primary goal of the project was to provide an opportunity for Canadian computer companies to design, test and have the effects of their products evaluated within designated field-trial sites. To fulfill this mandate, developmental hardware and software products were introduced into five different federal government departments.

The System

The particular application under examination for this impact assessment research involved the installation of a seventy-work-station local area network (LAN) within the policy sector of one large federal government department. All work-stations were classed as being "plug-compatible" with an IBM PC and consisted of three basic components : a tilt and swivel monitor with anti-glare screen and green or amber character coloring; a detachable bilingual keyboard; and an expansion chassis containing 640K of memory, a floppy disk drive, and network interface hardware. These work-stations were linked together by a coaxial-cable local area network incorporating two file server units, each of which contained 137 millions characters, or the equivalent of approximately 200,000 document pages of storage.

The software for the OCS network was composed of both off-the-shelf and customized packages which were selected or designed to mimic existing hardcopy processes and procedures, thus creating as little disruption as possible to established organizational structures. The system components could be grouped into four major categories : document creation, document storage, document transmission, and other functions. Document creation included text processing and an electronic spreadsheet; document storage involved personal space management and archiving; document transmission consisted of electronic messaging; and other functions permitted access to a calendar, personal computing, problem reporting, system administration and external communications. Most of these packages could be used in either English of French, and all users, regardless of linguistic preference, could create text in both official languages. Telidon and a logging and

tracking mechanism were also part of the original system specifications; however, these features never became fully operational during the field-trial period.

Research Methodology

Although methodologically this research could most accurately be described as a case study because of the specificity of the site, a quasi-experimental design was followed to assess the impacts of introducing computerized office equipment. Three primary data collections were conducted over a three-year period from the fall of 1983 to the spring of 1986 : 1) a pretest, six months prior to the installation of OCS; 2) an interim evaluation, six months after installation; and 3) a posttest, twenty months after installation. The complexity of the issues to be covered necessitated that the research team use variety of methods to compile all pertinent information. These methods included structured self-administered questionnaires, personal in-depth interviews with key informants, participant observation, and the examination of organizational records.

In keeping with the quasi-experimental design, the research involved not only staff members in the branch designated to receive OCS (OCS participants), but also a non-equivalent control group consisting of staff from another policy-oriented branch within the same department which had no access to OCS (transitional group). In addition, a third group was identified because a few members of the study population were using micro-electronic equipment prior to the OCS trial (long-term users).

Findings

In examining the consequences of implementing OCS, the Impact Assessment team concentrated on five primary areas :

1) Work attitudes;
2) Office environments;
3) Health;
4) Work processes and procedures; and
5) User acceptance.[1]

---

[1] A separate report on the OCS training program entitled How to Do It : Training for a Computerized Office System can be obtained from the Institute for the Study of Women, Mount Saint Vincent University, Halifax, Nova Scotia, Canada, B3M 2J6.

General Perspectives on Technological Change

In general, the literature on office automation presents three competing perspectives : 1) that the introduction of computer equipment will have a direct negative effect on the organization and equipment will have a direct negative effect on the organization and the well-being of employees by fostering diskilling, centralization, alienation, health problems, and a deterioration in the physical environment; 2) that the introduction of computer equipment will have a direct positive effect leading to the elimination of mundane tasks, increased efficiency, democratization, and more positive work attitudes; 3) that the consequences of computerization will be only indirectly mediated through organizationally specific factors such as the way in which the equipment is introduced, or pre-existing work patterns and organizational cultures.

Although the findings to be presented in this report identify a few direct consequences of introducing a local area network, the majority of the impacts were found to be contingent upon implementation procedures and related changes in job duties that evolved during the course of the field trial.

Work Attitudes

Work attitude measurements derived from self-administered questionnaires provided assessments of : general job satisfaction, supervision, co-workers, intrinsic job content, promotional opportunities, pay, job security, fringe benefits, perceived value of the job, degree of job specialization, responsibility, control over job content, control over movement, and control over the speed of work. Although many of these factors remained essentially unaffected by the introduction of OCS, there were demonstrable changes in respondents'assessment of responsibility, speed of work, supervision, pay, intrinsic job content, and the perceived value of the job. While a decline in the willingness to take personal responsibility for the results of one's work appeared to be directly linked to computerization, other observed changes were dependent upon the manner in which the equipment was introduced and subsequent revisions in the duties performed by specific job types.

Under all conditions, the results of this research project demonstrated that respondents became considerably less willing to be held responsible for the accurate and timely execution of their work once computerized office equipment was installed. This reaction could be related to the increased uncertainty created by software bugs, hardware glitches, power surges, and complete system malfunctions.
In contrast to this one apparently direct negative effect of introducing computers, other indirect negative consequences arose during the implementation period and were particularly

In contrast to this one apparently direct negative effect of introducing computers, other indirect negative consequences arose during the implementation period and were particularly pronounced for support staff. Even though the training and user-support provided for this site was much more extensive than that typically found throughout private industry and other government applications, workers were still expected to develop their computer-related skills while, at the same time, maintaining a regular work load. Under such circumstances, it is not surprising that people experienced pronounced time pressures. This is, of course, a significant problem not only for this particular application but also for most other implementing organizations that must continue operations throughout the transition to electronic work procedures. Although everyone experienced some pressure in the form of time constraints, support staff were in a particularly vulnerable position during the initial learning phase. Unlike officers, support staff had virtually no control over the functions for which they used the new computer system because their work procedures were governed primarily by the preferences of the professional and management personnel for whom they worked. In addition, many support staff felt the expectations of their superiors exceeded what they were able to accomplish given their own inexperience and the bugs and glitches in the equipment itself. These increased work demands and insecurities, coupled with the lack of compensatory pay raises, may have been responsible for the relatively negative assessments of supervisory practices and pay given by support staff during the first six months of computer usage.

While the implementation phase created an adverse situation for support staff, long-term informal changes in the structure of job tasks eventually led to an improvement rather than a continued deterioration in work attitudes. By the time of the posttest, support staff were relieved of many tedious and undervalued tasks such as text entry and editing (since officers were doing most of these themselves), and could spend more time on administrative duties which they found more interesting and rewarding.

Thus, the primary findings in the area of work attitudes could be summarized as follows :

1) **Computerization exhibited only one direct negative effect on work attitudes in that respondents were less willing to accept personal responsibility for the results of their work once they had made the transition to electronic procedures;**

2) **Even though the results demonstrated only one direct effect, the manner of implementation led to increased time pressures because staff were expected to develop their computer competency while at the same time maintaining a regular work load;**

3) **Assessments of supervisory practices declined among support staff during the initial implementation period because they felt the expectations of their superiors exceeded what they were able to accomplish given their own inexperience and the bugs and glitches that existed in the computer system itself;**

4) **In the long term, a restructuring of job duties led to officers conducting most of their own text entry, leaving support staff free to concentrate on administrative tasks which they found to be more intrinsically interesting and rewarding.**

Office Environments

In addition to social-psychological factors, it is important to examine the potential impacts of computerization on various aspects of the physical environment and the related perceptions of workers as machines introduce additional cables, increase heat and noise, change visual tasks, and occupy space. Particular consideration must be given to the relationship between computerization and the following three aspects of an office environnement : 1) ambient conditions including temperature, ventilation, lighting, visual quality, noise distractions, and acoustic quality; 2) space and layout; 3) installation issues including cabling and electrical wiring. While it is obvious that computerized office equipment can directly affect environmental conditions by producing heat, consuming space, and requiring additional wiring and cabling, the extent to which these changes are perceived as problematic may well be mediated by other considerations. In this field trial, the introduction of computerized office equipment was found to have numerous negative repercussions for respondent's assessments of their physical surrounding; however, the severity of such impacts were often contingent upon the tasks performed by the user and his/her office accommodation.

Following the installation of OCS, respondents reported increased levels of dissatisfaction in the areas of heat, ventilation, noise distractions, work space, and the locations of electrical outlets. Because the heating, cooling, and ventilating systems in the particular building under examination were zoned to serve half a floor, the increased strain created by the new computer network led to pervasively negative conditions. In addition, the OCS equipment introduced many new sources of noise in the form of printers, fans, bells, signals, and key-clicks. Work space was also at a premium as repondents made room for their monitors, keyboards, expansion chassis, and manuals. Finally, the building was not well equipped to meet the new electrical and cabling requirements. Thus, the installation was considerably more costly and complex than anticipated and users gave increasingly negative evaluations of the adequacy of existing electrical outlets. As a culmination of these detrimental changes, staff were significantly more likely to indicate that their physical environment had a negative effect on their ability to do their job after the OCS installation.

Although many of the observed changes in the physical environmemt were relatively diffuse, negative reactions were most pronounced in open areas. Office type can act as an intervening variable between automation and subsequent environmental impacts. Many environmental factors become particularly problematic in open areas because of the close proximity of equipment. Following the introduction of the OCS network, staff in open offices gave distinctly more negative assessments of heating, ventilation, and space allocations than did their counterparts in enclosed accomodations. Occupants of open offices were also substantially more likely to think that the physical surroundings had a negative effect on their ability to fulfill their job requirements.

While evaluations of lighting were not directly influenced by the introduction of the OCS equipment, an indirect negative change did occur among officers. As previously mentioned, these professional personnel had taken responsibility for most of their own text entry and editing by the time of the posttest data collection and this change in job content may have influenced their increased sensitivity to reflections on the VDT screen. Thus, computer-related changes in work processes and job duties can also have an indirect effect on assessments of the physical environment.

In conclusion, computerization can have both direct and indirect negative repercussions for workers' assessments of their physical accomodations :

1) **The installation of the OCS computer network led to increasingly negative evaluations of temperature conditions, ventilation, noise distractions, work space allocations, the location of electrical outlets, and the overall effect of the physical environment on the respondents' ability to conduct his/her work;**

2) **Heating, ventilation, and work space problems were particularly pronounced for users in open offices;**

3) **Although lighting was not a pervasive concern, officers were more bothered by VDT reflections once they started to conduct their own text entry and editing.**

Health

Technological change can affect both the physical and psychological health of the user population through headaches, eye strain, neck and shoulder pain, and stress. In general, the findings of the OCS project supported the organizationally specific hypothesis that it is instead health-related problems are more closely linked to environmental conditions and job content.

Characteristics of the physical environment such as temperature, ventilation, work space, and refections on the VDT were much more strongly correlated with the frequency of reporting health problems than the duration or intensity of computer usage. Moreover, an increasing frequency of eye strain and neck and shoulder pain was evident among officers as their job duties changed to incorporate text entry and editing. Alternatively, support staff experienced fewer symptoms in these areas as they performed more administrative tasks.

In summary :

1) **Computerization did not have either a direct positive or direct negative effect on the health of the user population; however, the physical environment and changes in job content did indirectly influence health factors;**

2) **Environmental conditions such as temperature, ventilation, work space allocations, and VDT reflections were particularly important in determining the frequency with which users experienced health problems;**

3) **Eye strain and neck and shoulder pain also increased among officers as they took more responsibility for their own text entry and editing requirements.**

Work Processes and Procedures

While popular opinion heralds computerization as a fast and easy solution to spiralling office costs, researchers are increasingly coming to recognize that the payoffs from office automation are to a large extent contingent upon organizational structures. Having identified the prominence of organizational structure as an intervening variable between office automation and productivity, there is still much disagreement over the most effective or efficient design of work processes. For example, some administrators argue that productivity gains can best be accomplished by instituting centralized word processing facilities so that operators can maximize the advantages to be derived from the improved entry and editing capabilites of the equipment. In direct opposition, others believe that such a structure increases the total time needed for document production because the separation of composer and typist creates the necessity for more frequent and detailed revisions. Thus, these people hold that the most pronounced improvements in productivity can be accomplished through decentralization with authors entering and editing their own text.

Traditionally, productivity has been conceptualized from an activity perspective. In the area of office automation, people have concentrated on such features as the number of keystrokes per minute or the number of pages input per hour. However, this may give a rather narrow view of the relationship between computerization and productivity. As the above example illustrates, diminished time requirements for text entry may do little to improve output if revisions are simultaneously increased. Therefore, to have a comprehensive understanding of the consequences of computerization, the researchers for this project followed a "particle orientation." Under this approach, specific documents were tracked from conception to completion in order to determine precisely where the new computer system had been influential and which areas remained unchanged. It is possible to examine not only improvements in the amount of time required to accomplish a specific task such as text entering but also to determine if the total lapsed time required to finalize a document has increased or decreased as a result of changes in the manner of conducting work.

For the purposes of analysis, the stages of document production were broken down as follows :

1) lapsed time between conception and execution (the time period from when a person decided or received an instruction to create a particular document and when he/she actually started working on that document);

2) information collection (the time required to gather the information necessary to compose a document);

3) composition (the time consumed in writing the first draft of a document);

4) review and revision (the time required for a document to be reviewed by superiors and accordingly revised by the author);

5) finalization and storage (the time required to format, print, and store the document either electronically or in paper form).

After 20 months of system usage, a substantial decrease was observed in the amount of time consumed before an author was able to start work on a particular task. As OCS improved the overall speed with which documents could be processed, fewer materials were backlogged and officers could therefore respond to specific requests more quickly. Some of officers also felt that the ease of access to similar pre-existing electronically stored materials encouraged immediate attention to short documents because first drafts could be created very quickly.

Even though computer-related improvements were evident in the area of imformation collection, many respondents felt that the vast potential of electronic procedures remained essentially untapped even after 20 months of use. The formation of a database of frequently used paragraphs greatly diminished the time required to gather information for routine correspondence. In addition, more timely and pertinent statistics could be produced as data files were downloaded from external mainframes to the OCS network. However, a number of participants felt that they had only scratched the surface of the benefits that could be reaped from OCS, and were eager to expand their horizons by connecting with many more outside electronic networks.

Although the text-processing potential of OCS directly enhanced the efficiency of first draft creation, the most pronounced improvements in this area arose from a reallocation of job duties. The lapsed time required to produce a first draft was virtually cut in half as authors no longer had to wait for word-processor operators or secretaries to have the time to enter or revise their materials. Likewise, professional staff felt personal computer access encouraged them to perfect their work by making extensive changes to original wording and sentence structure. Thus, the most significant time savings and qualitative changes occurred not so much as a direct result of improved equipment capabilities but instead as an indirect consequence of the development of more autonomous work procedures. As indicated above, the fourth stage of document processing encompasses two separate, although interrelated components : review and revision. Whereas the text-processing function was a definite asset with respect to revisions, the computer system did little to reduce the lapsed time consumed by the review process.

The decline in time requirements for revisions arose from much the same source as improvements exhibited within the initial draft creation stage. Officers no longer had to wait for secretaries to retype or word-processor operators to edit materials because such revisions could be accomplished directly at their own personal work stations. Once again, indirect changes in job responsibilities led to substantial savings in the total amount of time required to produce a final document.

Even though OCS offered many positive benefits, it did little to diminish the lapsed time for management review procedures, and this was precisely the component of the document production cycle that consumed the largest proportion of processing time. Few managers used the OCS system to review documents because they found it awkward to skim materials on the screen and impossible to make marginal comments. Moreover, the software package that was to assist in the transmission, logging, and tracking of internal electronic documents never became fully operational. While management usage of an electronic network could improve communication, this would still do little to alleviate the long waiting periods that arose as a consequence of the extensive organizational hierarchy. Because final authority was centralized at the top, senior managers had many competing obligations and substantial periods of time often lapsed before particular documents could be reviewed. Thus, marked improvements in this area could only arise from a restructuring of work processes ragher than as a direct result of technological change.

In contrast to all other stages, OCS may have actually prolonged the amount of time consumed in finalizing long policy documents because of problems that arose during translation. The contents of all important federal government papers must be printed in bilingual form with side-by-side paragraph alignment and the text processing package available on OCS was not capable of accepting such column entry. Therefore, the majority of documents eventually had to be tramsmitted to AES machines in the word processing centre. This was particularly problematic because the disk transfer created corrupt segments and inappropriate formatting. Even at the time of the posttest, a duplication of effort was still occurring because retyping on AES was deemed preferable to cross-system transfers.

Overall, the results of this research demonstrated that computerization offered pronounced improvements for many components of document production. Electronic text processing, computing and storage functions had a direct positive effect on the ease and efficiency of information retrieval, text creation, and editing. However, the largest proportion of lapsed time, from beginning to completion of a document, was comsumed by delays which occurred because the document was waiting to be typed, edited, or reviewed. Reductions in these components of the production cycle can only be accomplished through the development of more autonomous work processes and a flattening of the bureaucratic structure. thus, pronounced productivity gains require not only technological but also organizational change.

The primary changes in document processing that occurred during this field-trial period could be summarized as follows:

1) **The introduction of OCS had a direct positive effect on the time required to produce a document by improving the ease and efficiency of text entry and revision;**

2) **Even though improved equipment capabilities offered many advantages, the most substantial time savings in the total document processing cycle were derived from indirect changes in work procedures. After the introduction of OCS, the lapsed time needed to produce a document was significantly reduced because many officers entered and revised their own text, thus eliminating delays created by waiting for secretaries or word-processor operators to perform such tasks;**

3) **Although these changes in work procedures among support staff and officers decreased the time consumed in document composition and revision, review procedures were left essentially unaffected after 20 months of computer use. While electronic**

systems could conceivably improve communication channels, substantial time savings in this area would also require the development of more autonomous work processes through a flattening of the organizational hierarchy.

User Acceptance

To a large extent, the success or failure of a computer system is dependent upon the attitudinal and behavioral responses of the recipients. If workers dislike or refuse to use new electronic procedures, little can be accomplished in the area of productivity enhancement and such resistance, in turn, can adversely affect general morale within the organization. This particular section, therefore, examines the factors that may influence workers' reactions to the introduction of electronic processes. Particular consideration will be given to job type, work attitudes, demographic characteristics, environmental conditions and implementation procedures as determinants of user acceptance.

Both behavioral and attitudinal measures of acceptance were examined, and findings revealed that attitudes toward OCS underwent several changes. While initially positive (pretest), support staff became more negative six months after OCS was installed, then grew steadily more positive again troughout the following fourteen-month period. Since officers were doing most of their own text entry and editing by this time, leaving support staff to perform jobs which they liked better (budgeting, expense-claim processing, etc.), support staff attitudes towards OCS was more positive at the posttest than at the interim.

Turning to system use, it had increased significantly by the posttest, for both support staff and officers. However, managers who had reported the lowest usage at the interim period, showed further declines by the posttest. In spite of this, they evaluated the system positively as they felt it was useful for the officers and support staff working with them.

Acceptance did not vary by age or education; and several factors which had been significantly correlated with the introduction of OCS at the interim period (the evaluation of supervisors, intrinsic job content, and the perceived value of their jobs) lost their significance over time. Indeed, only the positive correlation between the evaluation of promotion opportunities and user acceptance remained at the posttest.

In general, the associations between work attitudes, environmental conditions and system use were negative rather than positive and the most significant indicators were in the area of control. During the implementation period, respondents who had the most control over their work procedures used the new electronic functions the least. Given the choice, people may not make extensive use of a new system until most of the bugs and glitches have been corrected. Once the computer network was relatively stable, 20 months after installation, control over speed was the only factor that stood out as having a significant association with computer use. Those individuals who experienced constant time pressures used the new procedures the least. Time must be allocated for the whole learning process of people are to become proficient in the application of new procedures. It is not surprising that self-instruction on electronic processes takes low priority if people are already struggling with heavy workloads.

In terms of language, French-language and bilingual users still evaluated the system less favorably than English-language users at the posttest, but the differences were less pronounced that at the interim period. This may indicate that the English-language bias of the manuals (most of which were created in Englis and then translated) becomes less important as familiarity with the system increawses.

Two other factors were related to the acceptance of OCS. First, the more information users felt they had been given obout the introduction of OCS, the better their acceptance. Secondly, those who felt that training was adequate, and that it was easy to apply what they had learned in training to their jobs, evaluated the system more positively, and used the new functions more extensively, than those who found the training inadequate and the information difficult to apply.

While favorable working conditions may play an important role in encouraging positive attitudinal responses to the introduction of a computer system, this is no guarantee that people will make use of the equipment once it is in place. The extent to which people use a new computer system depends on the provision of appropriate training, the allocation of time for users to practice new procedures, and the provision of software and manuals that are applicable to the linguistic and functional requirements of the implementing organization.

The following primary conclusions were formulated in the area of user acceptance :

1) In general, the response to OCS was very favorable. Posttest results demonstrated that, on average, people were spending more than 50 percent of their working time using the system and the vast majority felt that the new equipment had improved both the content and ease of their work;

2) It is, however, important to distinguish between attitudinal and behavioral measures of user acceptance because the factors that promote positive opinions about computerization may differ substantially from the conditions under which extensive system usage will develop;

3) In the federal government context under discussion, promotional opportunities stood out as having the strongest and most consistent effect on attitudinal measures of user acceptance. Those individuals who felt their jobs offered little room for advancement were the least likely to beleive the new computer system had made a positive impact on their work;

4) Although assessments of intrinsic job content, supervisory practices, and environmental conditions formed significant predictors of initial attitudinal responses to OCS, the relevance of these considerations declined after more lengthy exposure;

5) From a behavioral perspective, respondents who could exercise a great deal of control over their personal work procedures did not make extensive use of OCS until the major bugs and glitches had been resolved, and those experiencing constant time pressures were also less likely to develop and use their computer-related skills in the long term;

6) Both attitudinal and behavioral measures of user acceptance were, comparatively low among French and bilingual users, perhaps as a result of inappropriate translations and the inability of OCS to accept side-by-side bilingual text through column entry;

7) Finally, training and information dissemination indicators were the only factors that exhibited positive correlations with system usage as well as users' attitudinal responses to OCS. If respondents felt positive about the training program and the information provided on the new computer system, they were more likely to think OCS was beneficial for their jobs and also to make extensive use of the equipment.

Conclusion

Our key findings, then, were that the effects of office automation will be primarily dependent upon the design and the uses to which it is put in a given organization. In this field trial, efforts were made to interfere as little as possible with the organizational status quo, adapting the technology to existing practices wherever possible. While this meant that such practices were not critically reviewed, it minimized the disruption inherent upon changing them. Il also meant that job security was not threatened.

The introduction of micro-electronic technology did accentuate existing environmental deficiencies, and it did appear to reduce feelings of responsibility because of the introduction of technical problems. Moreover, indirect changes occurred in the content of the jobs of both support staff and officers, and these appear to have been important in eliminating delays at lower levels of the production process. However, these new procedures were counterbalanced by blockages further up the hierarchy, blockages due to organizational structure and thus not amenable to amelioration through automation. Focussing on the users, acceptance increased over time and was generally high. Although use by managers was also quite extensive, they did not find the new electronic functions appropriate for their job duties.